Discussion with

NAI Icy Satellites Environments Focus Group

NASA Outer Planets Assessment Group

William B McKinnon, Chair

Washington University

Sept 8, 2010

What is OPAG?

The Outer Planets Assessment Group (OPAG) was established by NASA in late 2004 to identify scientific priorities and pathways for solar system exploration beyond the asteroid belt. The group consists of an ~15-person steering committee which actively solicits input from the scientific community and reports its findings to NASA's Planetary Science Division and the Planetary Science Subcommittee of NASA's Advisory Council.

It is OPAG's goal that its findings represent the broad consensus of the scientific community. OPAG holds meeting semiannually, each attended by ~100 scientists. The meetings consist of a broad range of presentations from NASA HQ representatives, mission PIs, individual scientists, and technology researchers. Meetings often include breakout sessions where scientists work in small groups to prioritize scientific questions and mission requirements at specific destinations (e.g., Europa, Titan, giant planets, midsize icy satellites such as Enceladus). Community input is solicited at the meetings and through the OPAG email list containing over 500 members.

Outer Planets Assessement Group Steering Committee

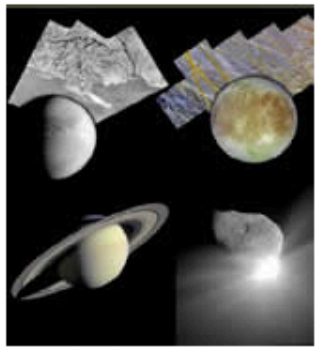
William McKinnon, Washington University (Chair, 2009-)
Fran Bagenal, University of Colorado (Chair, 2004-2009)
Sushil Atreya, University of Michigan
Kevin Baines, Jet Propulsion Laboratory
Pat Beauchamp, Jet propulsion Laboratory
John Clarke, Boston University
Jack Connerney, Goddard Space Flight Center
Frank Crary, Southwest Research Institute, San Antonio
Paul Geissler, US Geological Survey
Randy Gladstone, SwRI, San Antonio
Ron Greeley, Arizona State University
Heidi Hammel, Space Sciences Institute
Bill Hubbard, University of Arizona
Torrence Johnson*, Jet Propulsion Laboratory
Bill Kurth, University of Iowa
Ralph Lorenz, JHU/APL
Ralph McNutt, JHU/APL
Bill Moore, University of California – Los Angeles
Julianne Moses, Lunar and Planetary Institute
Jani Radebaugh, Brigham Young University
Amy Simon-Miller, NASA Goddard SFC
Henry Throop, SwRI, Boulder
Hal Weaver, JHU/APL
David Williams, Arizona State University
Curt Niebur, NASA HQ (Executive Officer)
*Ex Officio

Current members in **bold**. The Steering Committee is selected to represent the breadth of the scientific community. Each member typically serves for three years.

Lunar and Planetary Institute | + View the NASA Portal

OPAG
Outer Planets Assessment Group

- + OPAG COMMITTEE
- + OPAG UPDATES
- + OPAG INDICATION OF INTEREST
- + OPAG REPORTS
- + OPAG PRIVATE LINK
- + OUTER PLANETS DISCUSSION DOCUMENTS
- + MISSIONS
- + TECHNOLOGIES
- + OUTER PLANETS RESOURCES
- + STUDENT OPPORTUNITIES
- + OPAG CALENDAR



Scientific Goals and Pathways for Exploration of the Outer Solar System

Outer Planets Assessment Group

The Outer Planets Assessment Group was established by NASA in late 2004 to identify scientific priorities and pathways for exploration in the outer solar system. The group consists of a 15-person **steering committee**, which actively solicits input from the scientific community and reports its findings to NASA Headquarters. OPAG provides input to NASA but does not make recommendations.

OPAG CHARTER

OPAG is NASA's community-based forum designed to provide science input for planning and prioritizing outer planet exploration activities for the next several decades. It is chartered by NASA's Solar System Exploration Division and reports its findings at meetings of the Solar System Exploration Sub-Committee of the NASA Space Science Advisory Committee. Open to all interested scientists, OPAG regularly evaluates outer solar system exploration goals, objectives, investigations and required measurements on the basis of the widest possible community outreach.

NEXT OPAG MEETING

NEW **September 16–17, 2010**
Boulder, Colorado
Millennium Harvest House
(800) 545-6285
Preliminary Agenda

www.lpi.usra.edu/opag

The OPAG meeting is only a few weeks away! The meeting will take place Sept. 16-17 at the Millennium Harvest House in Boulder, CO. The bulk of the meeting will focus on the upcoming Announcement of Opportunity for instruments for the Jupiter Europa Orbiter. This is an excellent opportunity to not only hear details about potential AO parameters and policies but to provide NASA with your feedback on those policies. The Program Scientist, Curt Niebur, is looking forward to extended discussion and debate about this AO — this is your chance to learn about the AO and exert influence on its contents.

A limited number of hotel rooms are available in the NASA block at the Millennium Harvest House. You can reserve one by following the directions provided on the logistics **website**. Please also take a moment to register so we can appropriately size the meeting. Unfortunately, the meeting dates fall on a busy time in the Boulder area, and the hotel can only hold the rooms in the NASA block until Friday, Aug. 27, so please don't delay. We will be posting a list of alternative hotels here and on the logistics website in the near future.

NASA structure simplified

- Administrator (Charlie Bolden)

  NAC (NASA Advisory Council)

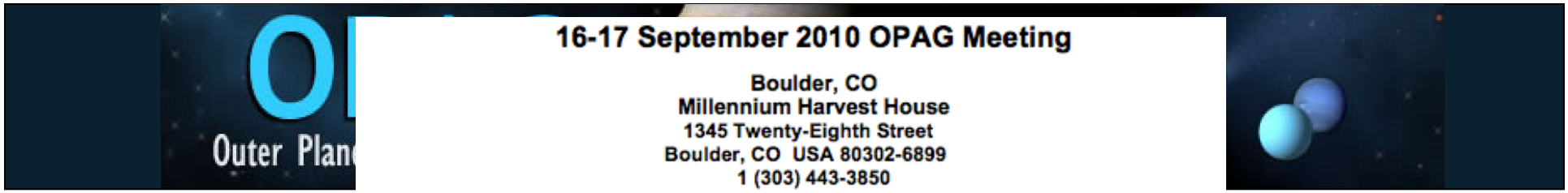
- Associate Administrator for the Science Mission Directorate (SMD), Ed Weiler

  Science Committee of the NAC, Wes Huntress chair

- Planetary Science Division Director (PSD), Jim Green

  Planetary Science Subcommittee (PSS), Ron Greeley chair

  Outer Planets Assessment Group & other AGs
  (AG Chairs serve on PSS)



16-17 September 2010 OPAG Meeting

Boulder, CO
Millennium Harvest House
1345 Twenty-Eighth Street
Boulder, CO USA 80302-6899
1 (303) 443-3850

PRELIMINARY AGENDA

Wednesday 15 September

Titan Debate at 7 p.m.		
Denver Museum of Science and Nature		Jeff Moore (NASA Ames) and Ralph Lorenz (APL)

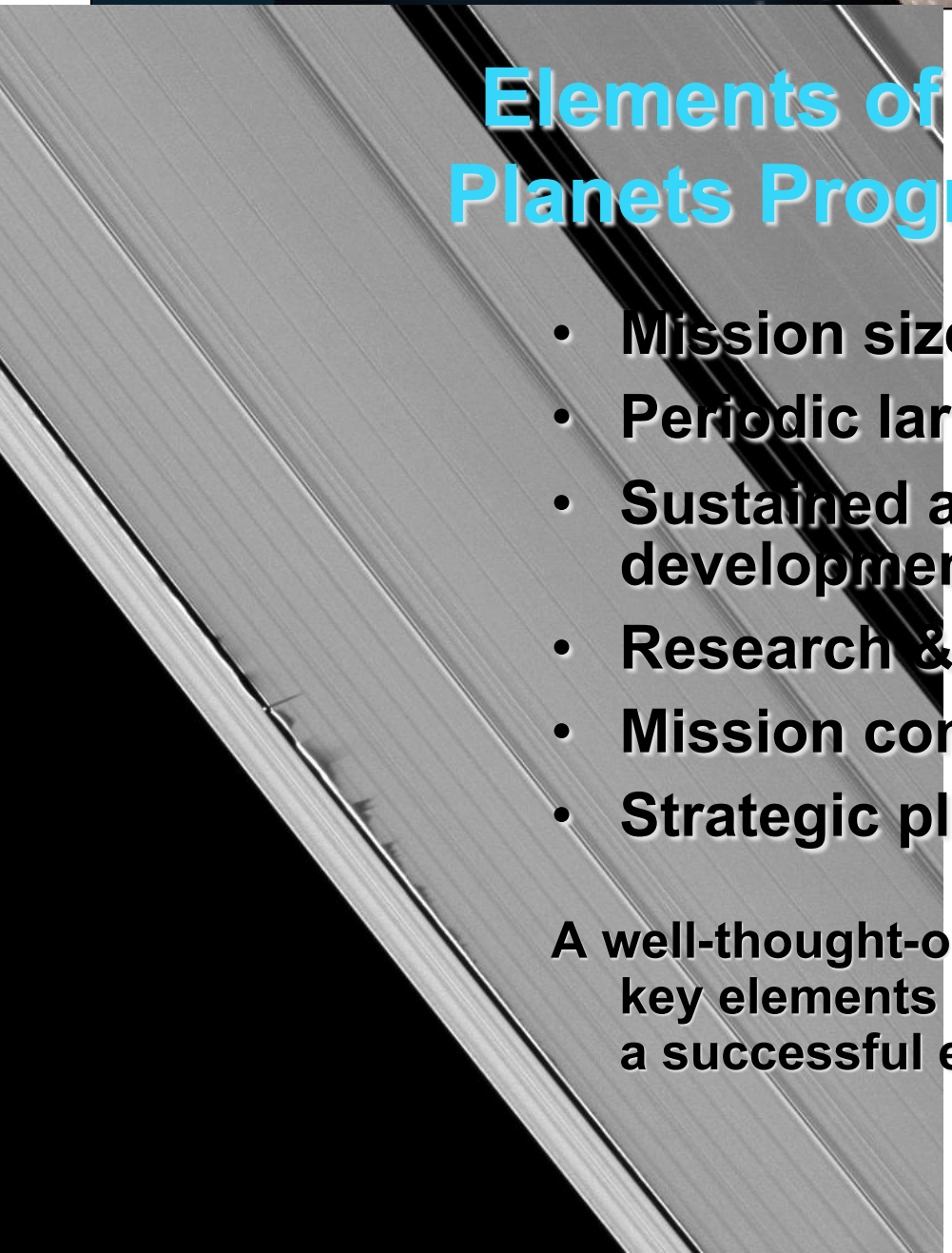
Thursday 16 September

8:00 am	Continental Breakfast	
8:30	Introduction & Goals	Bill McKinnon (Washington Univ)
8:45	HQ Update	Jim Green (NASA HQ)
9:15	Outer Planets Program Update	Curt Niebur (NASA HQ)
9:30	PSS Report	Bill McKinnon (Washington U)
9:45	PSS R&A Study	Ron Greeley (ASU)
10:15	Break	
10:30	Plutonium Outlook & ASRG Status	Len Dudzinski (NASA HQ)
11:00	EJSM Joint SDT Update	Ron Greeley (ASU)
11:30	EJSM AO Overview	Curt Niebur (NASA HQ)
12:15	Lunch	
1:45	Steps 1 & 2 of the AO	Curt Niebur (NASA HQ)
2:45	JEO Project Role in Steps 1 and 2	Bill Mateer (JPL)
3:15	Break	
3:30	Planetary Mission Sociology	Janet Vertesi (Princeton)
4:30	Steering Committee Meeting	
	Group Dinner	

OPAG Agenda Continued

Friday 17 September

8:00 am	Continental Breakfast	
8:30	Science Team Structure	Curt Niebur (NASA HQ)
9:30	Draft AO Policies and Plans	Curt Niebur (NASA HQ)
10:30	Break	
10:45	Planetary Protection	Cassie Conley (NASA HQ)
11:30	PSD Technology Review Panel	Tibor Kremic (Glenn)
12:15	Lunch	
1:30	NAI Icy satellites Environments Focus Group	Pat Beauchamp (JPL)
1:45	Juno Update	Fran Bagenal (UC Boulder)
2:00	Astronomy and Astrophysics Decadal Survey	TBD
2:30	Open Mike	
3:00	Findings/Discussion	All
3:30	Other Business	
	Adjourn	

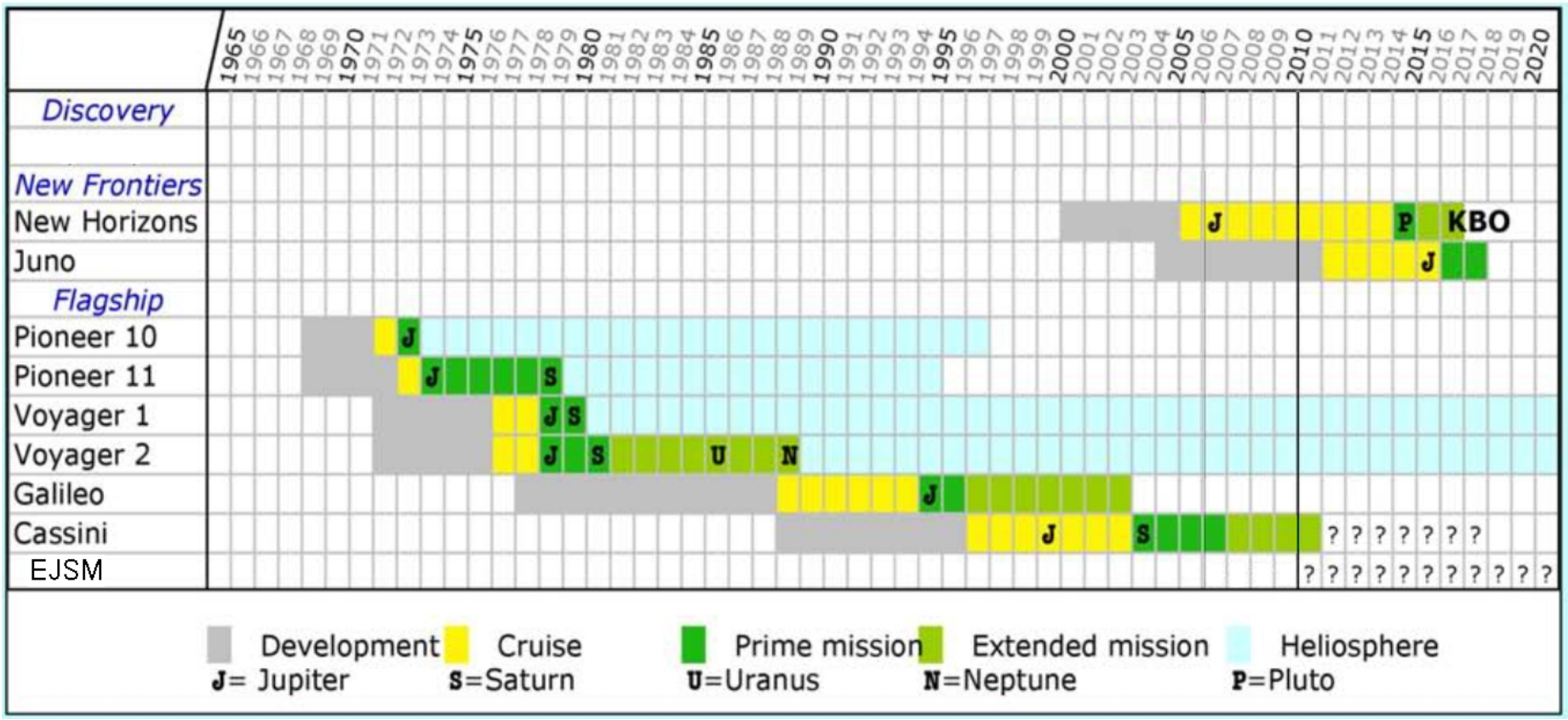


Elements of a Successful Outer Planets Program (not in priority order)

- Mission size mix (program balance)
- Periodic large (flagship) missions
- Sustained and focused technology development
- Research & Analysis
- Mission concept studies
- Strategic planning

A well-thought-out systems approach incorporating all key elements is required to promote and accomplish a successful exploration plan

Outer Solar System Missions proceed over long time scales



Flagship Studies (initiated at OPAG's urging)

2007: Europa Explorer, Titan Explorer, Enceladus Flagship, Jupiter System Observer (Ganymede Focus)

2008: Europa Jupiter System Mission (EJSM), Titan Saturn System Mission (TSSM)

Science ranked equally excellent; apple (E) vs. orange (T)

Prioritization of EJSM based on technical readiness

OPAG Science Recommendations

- **OPAG recommends that the Decadal Survey explore the possibilities for a program structure/categorization that could allow 'small flagship' class missions to be considered.**
- **OPAG strongly endorses the prioritization by NASA of the Jupiter Europa Orbiter (JEO) as the next Outer Planets Flagship and as part of the Europa Jupiter System Mission (EJSM) with ESA.**
- **OPAG strongly endorses approval by NASA of the Cassini Solstice Mission, including the Juno-like end-of-mission scenario.**
- **OPAG advocates the need for a focused technology program for the next Outer Planet Flagship Mission, which should be to Titan and Enceladus, in order to be ready for a launch in the mid-2020s.**
- **New Frontiers class missions that should be considered in the interim include (but *not in priority order)* a shallow Saturn probe, an Io observer, a Titan *in-situ* explorer or probe, a Neptune/Triton/KBO flyby and a Uranus Orbiter.**
- **Support for underlying Research & Analysis, Laboratory Studies, and Earth-based observations should continue.**
- **Effective international involvement is strongly encouraged in the planning, development, and analysis phases of all space missions to the Outer Solar System, beginning at the earliest stage possible.**

Technology overview

OPAG advocates the need for a focused technology program for the next Outer Planet Flagship Mission after the Europa Jupiter System Mission (EJSM), in order to be ready for a launch in the 2020s.

Current planning shows that a mission to Titan and Enceladus will be highest priority.

Technologies that require long-term investment for missions beyond the next decade should also be considered.

See **Technologies for Outer Planet Missions White Paper,** Pat Beauchamp, JPL, lead author

Specific OPAG Recommendations for technology

POWER

OPAG strongly recommends that NASA work with the relevant agencies to ensure that Pu-238 production provides enough material for future OP missions, and fully support the validation of the ASRG system for OP applications, including the development of small (milli-/multi-watt) radioisotope power generators for sensor networks. In addition, NASA should adapt and complement industry-developed advanced solar cell and array technology program, advanced battery technology, and advanced power conversion and distribution technologies program for OP missions.

TRANSPORTATION

SMD should continue its development of EP components and consider development of an off-the-shelf multi-mission SEP module (not only for the OP missions) that would be available to users with acceptable cost and risk constraints. Aerocapture development should focus on needs identified for Titan and Neptune, and risk reduction resulting in flight readiness is strongly encouraged to open up this mission enhancing, and for Neptune, enabling technology.

COMMUNICATIONS

NASA should expand the funding of communication and radio science technologies required for the OP, especially making Ka-band operational and furthering proximity and direct-to-Earth communication technologies.

PLANETARY PROTECTION

OPAG strongly recommends that PP requirements to the OPs be defined early, especially for Titan and Enceladus, and that investments be made to jointly develop solutions and technologies for PP and contamination control.

IN SITU PLATFORMS

OPAG recommends a sustained investment in this decade that would result in the demonstration of technical readiness for launch of a Titan balloon, and that NASA support the development of key autonomy capabilities required for a Titan balloon. Further, OPAG recommends that NASA invest in focused studies of Titan lander concepts and associated entry, descent and landing technologies, and mature the technologies necessary for surface sampling in different environments.

ENTRY SYSTEMS AND PLANETARY PROBES

OPAG recommends investments be made in key technologies for entry systems and planetary probes; extreme environment systems, miniaturized, low-power integrated sensors, transmitters, avionics, thermal materials, power management systems, entry, descent and landing technologies, and onboard processing.

EXTREME ENVIRONMENTS

OPAG recommends that NASA fund a technology program focusing on designing and testing low (and high) temperature components and subsystems that could be used throughout the spacecraft (or probe) and instruments. Initiating this program as soon as practicable would have a major impact on the feasibility of a Titan Flagship mission and would also enable New Frontiers missions.

SCIENCE INSTRUMENTS

OPAG recommends that NASA initiate a well-funded instrument development program that goes beyond the present low TRL instrument development programs. To prepare for future OP missions, NASA should establish a focused program that matures in situ and remote sensing instrument system concepts to TRL > 6.

What's next for OPAG?

1) Release of Decadal Survey

2) New Members (volunteers welcome!)